LOW COST INVERTER CIRCUIT DESIGN

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Submitted to the

Department of Electrical and Electronic Engineering
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In partial fulfillment of the requirements for the degree of
Bachelor of Science in Electrical and Electronic Engineering
(B.Sc. in EEE)

[Fall, 2009]

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ABSTRACT

Inverter is a device that converts electrical energy from dc form to ac form using electronic circuit. Its typical application is to convert a battery voltage into conventional household AC voltage allowing you to use electronic devices when an AC voltage is not available. Inverters are used in a wide variety of applications from small car adapters to high-power converters in solar and wind powered systems.

This is the circuit which outputs 110 V, while frequency of the device is 53~55 Hz, of the alternating current from the input of 12 V of the direct current. It is convenient to use the equipment which works in the alternating current using the battery. The inverter that we have made uses power MOSFET as switching device. Most commercially manufactured models use the same basic multi-stage concept: first a switching pre-regulator steps up a voltage from an input source to a DC voltage corresponding to the peak value of the desired AC voltage. The output stage then generates a desired AC voltage. This stage usually uses full-bridge or half-bridge configurations. If a half-bridge is used, the DC-link voltage should be at least twice the peak of the generated AC voltage. If a low-frequency transformer is used, the sinusoidal voltage is generated on its primary side and transformed to the secondary side. The output voltage level can be controlled either in square-wave mode or in pulse width-modulated (PWM) mode. Sine-wave circuits use PWM mode, in which the output voltage and frequency are controlled by varying the duty cycle of the high frequency pulses. Chopped signal then passes through a low pass LC-filter to produce a clean sinusoidal output.

ACKNOWLEDGEMENTS

We are very pleased to express our respect to our supervisor of this thesis Emamul Ahsan, Lecturer of Electrical and Electronic Engineering Department, East West University for his sincere observations, co-operations and suggestion. We thank him for his encouraging attitude and constructive feedback.

Special thanks to Dr. Anisul Haque, Chairperson of Electrical and Electronic Engineering Department, East West University for his guidelines and support.

We would like to thank Pinak Pani Mondal, Lab-in-Charge of Electronics & machine lab for his generous assistance.

We express our thanks to all the teachers, students and staffs of the Department of Electrical and Electronic Engineering of East West University.

Above all we thank our Almighty for giving us the ability, patience and energy to complete this project efficiently.

AUTHORIZATION PAGE

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1. INTRODUCTION

An inverter is a circuit that gives AC output for a DC input. A basic inverter circuit includes four step procedures (Figure 01). At first, a Pulse Width Modulator generates pulse. The output connected to switching portion. Switching poles are arranged into bridge circuits that are operated so as to provide a desired voltage, current and/or power waveform to a load. Then step up and filtering the output of the switching circuit gives desired output.

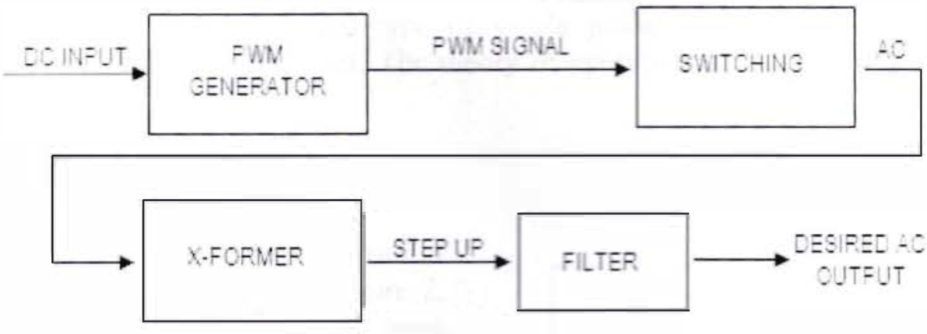

Figure 01: Block diagram of an inverter circuit.

2. HISTORY

From the late nineteenth century through the middle of the twentieth century, DC-to-AC power conversion was accomplished using rotary converters or motor-generator sets (M-G sets). In the early twentieth century, vacuum tubes and gas filled tubes began to be used as switches in inverter circuits.[1] The most widely used type of tube was the thyratron. The origins of electromechanical inverters explain the source of the term inverter. Early AC-to-DC converters used an induction or synchronous AC motor direct-connected to a generator (dynamo) so that the generator's commentator reversed its connections at exactly the right moments to produce DC. A later development is the synchronous converter, in which the motor and generator windings are combined into one armature, with slip rings at one end and a commentator at the other and only one field frame. The result with either is AC-in, DC-out. With an M-G set, the DC can be considered to be separately generated from the AC; with a synchronous converter, in a certain sense it can be considered to be "mechanically rectified AC". Given the right auxiliary and control equipment, an M-G set or rotary converter can be "run backwards", converting DC to AC. [1]

3. THEORY

3.1 SWITCHING CIRCUIT

The switching can be done in many ways. The most common switching circuit comes with single phase bridge inverter. There are two type of single phase bridge inverter. The switching procedure is nearly same of both types. The theory of operation of the two inverters described below-

3.1.1 Single phase Half-Bridge Inverter

Single phase Half-Bridge Inverter consists of two switches Q_1 & Q_2 as shown in Figure 2. The two switches can not be on at the same time. When Q_1 switched on Q_2 remains switched off. When Q_2 switched on Q_1 remains switched off. When Q1 remains on then considering source to load, current conducts through Q_1; at that time voltage across the load is V/2. It happens when first half cycle of figure 3 comes. At that time Q_2 remains switched off. When Q_2 switch is on then current goes from load to source, conducting device is D2 and the output voltage is V/2. That happens for the second half cycle of figure 3. This time Q_1 remain switched off.

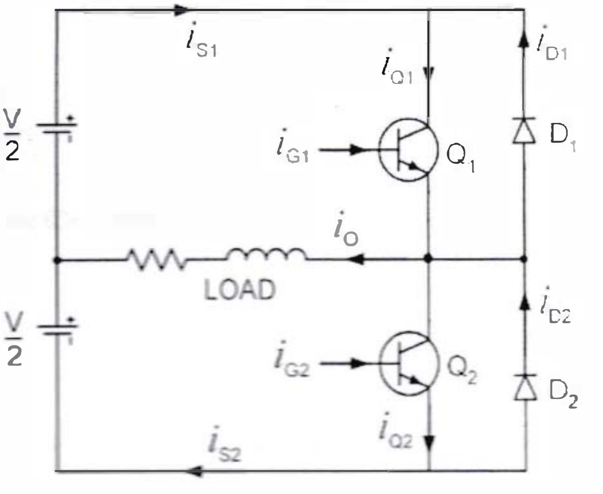

Figure 02: Single phase Half-Bridge Inverter.

This switching is made possible by controlling the PWM signal input. For a square wave input the switching is shown in Figure 3.

Switching status:

Table 01: A Half-Bridge Inverter Switching Stages.

STAGE	SWITCH ON	CONDUCTING DEVICE	V_{OUT}
1	Q_1	Q_1	$V_s/2$
2	Q_2	D_2	$-V_s/2$

For the Half bridge inverter the switching status is explained below using a square PWM with the help of Figure 3. Here one thing is noticeable that during the switching procedure for the active switch Q_1 & Q_2 precisely the device Q_1 & D_2 conducts the current.

In the first case, the output current reverses its direction at t_X. Output voltage reverses its direction at T/2. Therefore, from t_X to T/2 the output current will flow through Q_1. Later on, from T/2 to t_Y the output current will flow through D_2.

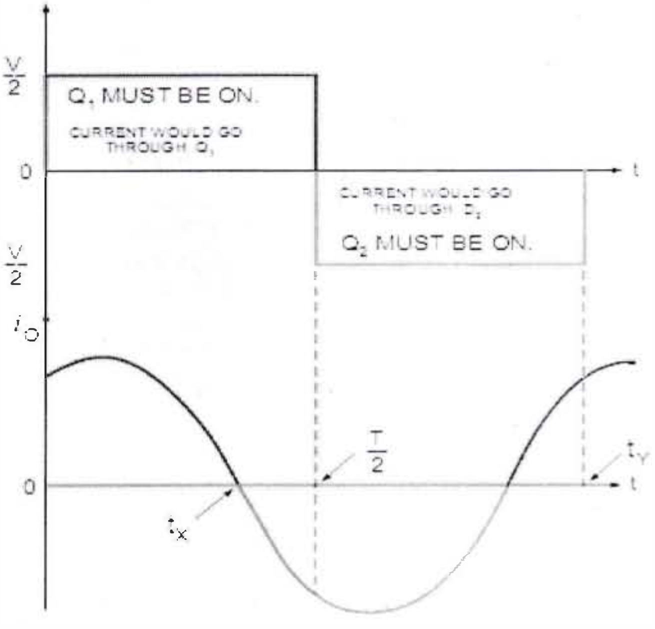

Figure 03: Current flow during switching procedure.

3.1.2 Single phase Full-Bridge Inverter

A single phase inverter consists of 4 semiconductor switches connected in a bridge configuration as shown in figure 4. Actually Single phase Full bridge inverter works two stages. During first half cycle of a period, switch Q_1 and Q_3 are driven simultaneously with a pulse having a duration modulated by the duty cycle. At that time conducting device is Q_1 and Q_3. Output current i_0 comes from source to load, that has shown in figure 5. During second half cycle, gates Q_2 and Q_4 are driven simultaneously by a symmetric pulse same as the first half cycle. At that time conducting device is D_2 and D_4. Output current i_0 goes from load to source shown in figure 7. This mode of switching operates the associated MOSFET's giving a bipolar PWM input.

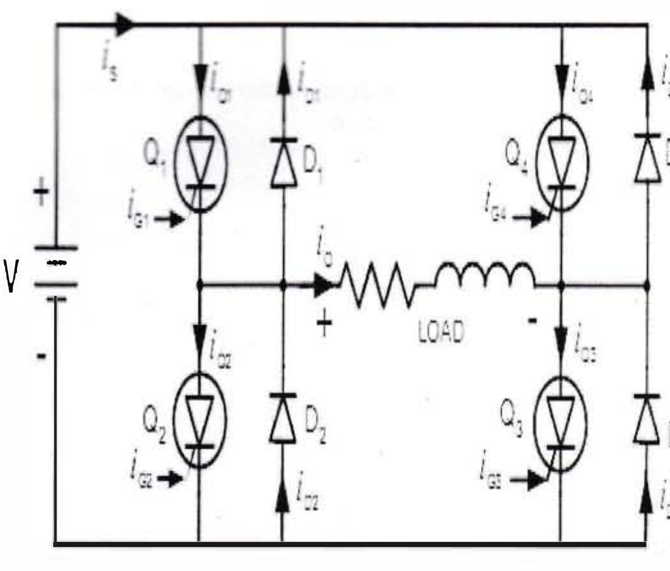

Figure 04: Single phase Full bridge inverter.

Switching status:
A single phase Full-bridge inverter switching happens in four stages. The four main stages are shown in Table 02. The four stages have been discussed below with the help of a PWM square wave input.

Table 02: A Full-Bridge Inverter Switching Stages.

STAGE	SWITCH ON	CONDUCTING DEVICE	V_{OUT}
1	Q_1, Q_3	Q_1, Q_3	V_S
2	Q_2, Q_4	D_2, D_4	$-V_S$
3	Q_1, Q_4	Q_1, D_4	0
4	Q_2, Q_3	D_2 , Q_3	0

Stage 1:
At first stage Q_1 & Q_3 turns on, other two switch remains off. If we consider source to load configuration then Q_1 & Q_3 (i_{G1} & i_{G3}) gives the output current i_0 across load, which is shown in figure 6. This stage gives a positive voltage output.
Considering load to source configuration makes the current flows through D_1 & D_3.

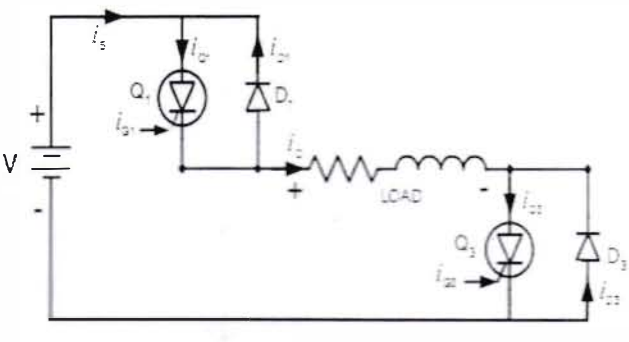

Figure 05: Single phase Full bridge inverter when Q_1 & Q_3 ON.

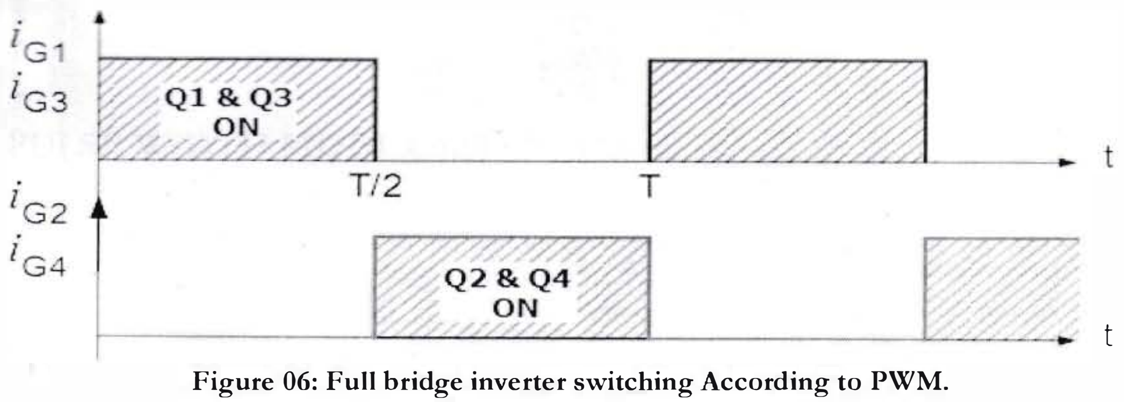

Figure 06: Full bridge inverter switching According to PWM.

Stage 2:

At first stage Q_2 & Q_4 turns on, other two switch remains off. If we consider source to load configuration then D_2 & D_4 (i_{G2} & i_{G4}) gives the output current i_0 across load, which is shown in figure 6. This stage gives a negative voltage output.

Considering load to source configuration makes the current flows through Q_2 & Q_4.

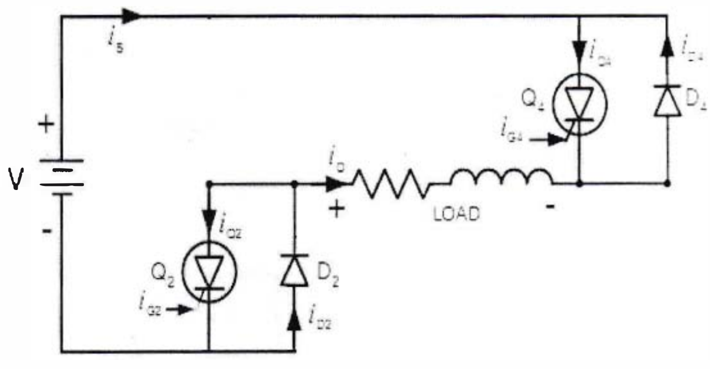

Figure 07: Single phase Full bridge inverter when Q2 and Q4 ON.

Stage 3 & 4:

Stage 3 and stage 4 makes the output voltage zero and there is no current flow through load. For this reason these two stages are useless for the desired inverter operation. These two situations are explained by figure 8 and figure 9.

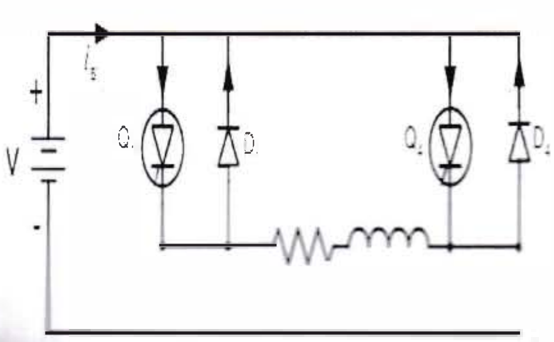

Figure 08: Switching stage 3 (Q_1, Q_4 ON).

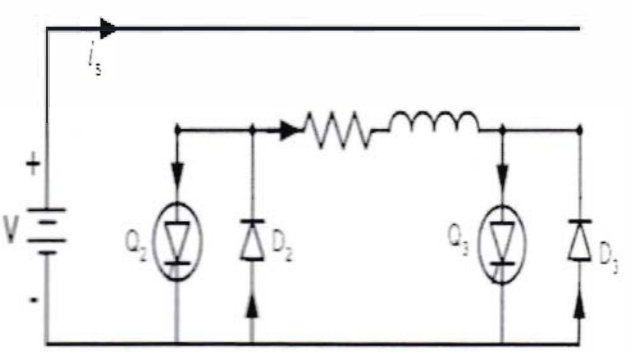

Figure 09: Switching stage 4 (Q_2, Q_3 ON).

3.2 PULSE WIDTH MODULATION (PWM):

PWM stands for Pulse Width Modulation. The main point of PWM is to create some average voltage via turning some maximum voltage completely turning on and off rapidly with the required duty cycle. [2] The primary reason to do this is to avoid wasting energy in some semiconductor by dropping the undesired voltage in it (linear region) which also burns up the semiconductor device. [2]

The output of an inverter depends on the PWM pattern applied to the leg switches. The PWM pattern should be strictly symmetric and periodic in nature. 180^0 Phase PWM patterns are needed for the inverter switches with sufficient interlock (dead band) between top and bottom switches in a leg. The procedure for generating a single pulse PWM waveform per half cycle is shown in Figure 10. Here a comparator having voltage V_{ref} and saw tooth waveform as comparator in put. V_{ref} is compared with the saw tooth waveform and output of the comparator is PULSE WIDTH MODULATION (PWM) signal.

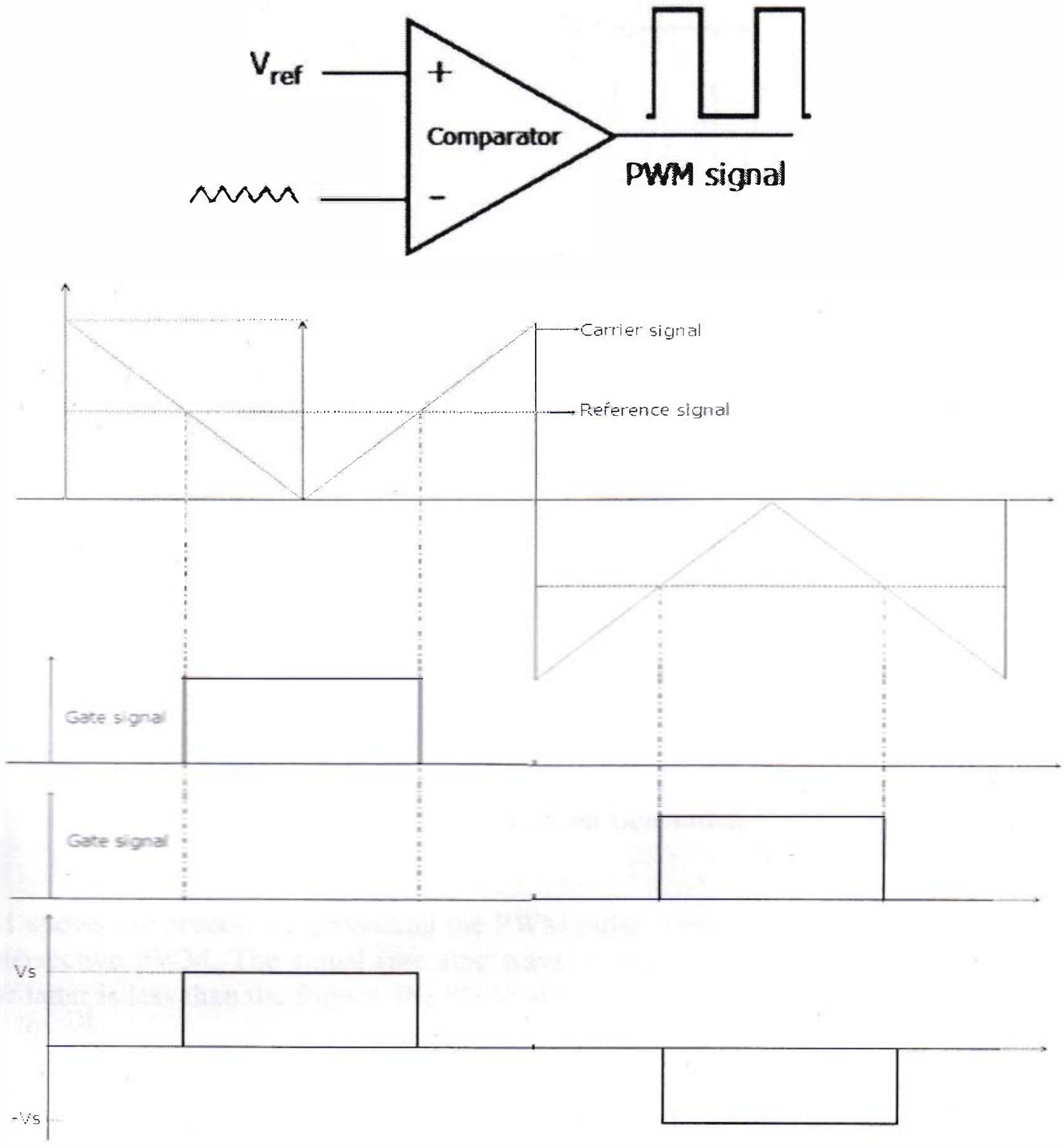

Figure 10: PWM Waveform Generation sequence for a single phase bridge inverter

Figure 10 shows the generation of gating signals and output voltage of a single phage full- bridge inverters [2]. The gating signal is generated by comparing a rectangular reference signal with a triangular carrier wave. The carrier signal and reference signals intersection point defines each transition of every cycle. This point is called as the threshold point. Two gate signals are generated with this procedure. One is positive cycle and another is negative cycle. At last stage two gate signals generates a complete PULSE WIDTH MODULATION (PWM) signal [3]. This process can also be shown with the figure below-

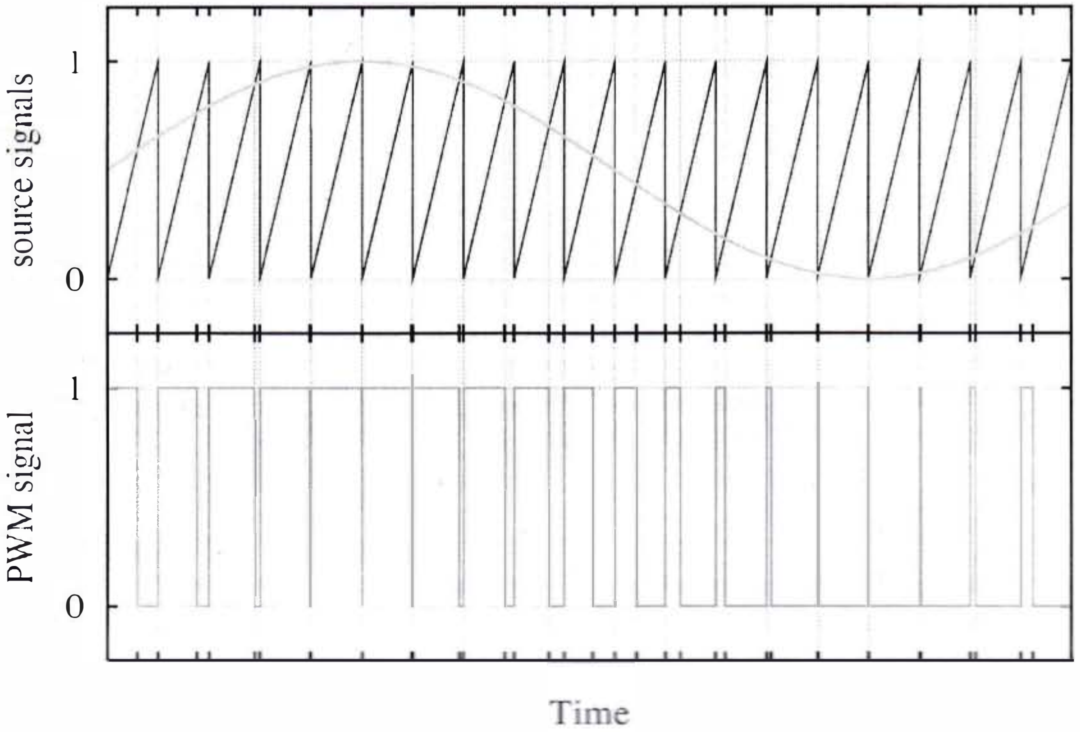

Figure 11: PWM Waveform Generation

Figure 11 shows the process of generating the PWM pulse train corresponding to a given signal is the intersective PWM. The signal (the sine wave) is compared with a saw-tooth waveform. When the latter is less than the former, the PWM signal is in high state (1). Otherwise it is in the low state (0). [3]

3.2.1 Different types of pulse-width modulation (PWM)

There are mainly four different type of pulse-width modulation is possible. Which are-

1. The pulse center may be fixed in the center of the time window and both edges of the pulse moved to compress or expand the width.[4]

2. The lead edge can be held at the lead edge of the window and the tail edge modulated. [4]

3. The tail edge can be fixed and the lead edge modulated.[4]

4. The pulse repetition frequency can be varied by the signal, and the pulse width can be constant. However, this method has a more-restricted range of average output than the other three.[4]

We have used the first type of pulse-width modulation (PWM) in this experiment.

3.3 Categories of voltage source inverter

Pulse-Width Modulation (PWM) is a way of controlling the power of an electric circuit that wastes very little electricity. According to modulation technique difference voltage source inverter can be differentiated as below-

1. Pulse width modulated inverter:
In this inverter the input dc voltage is essentially constant in magnitude. The inverters magnitude and frequency matching of the AC output voltage is achieved by controlling inverters switching process. PWM is used at the inverter switches for the switching process and hence this inverter is known as PWM inverter.

2. Square wave inverter:
In this inverters input DC voltage is controlled in order to control the magnitude of the AC output voltage. Therefore the inverter has to control only the frequency for the AC output voltage. The AC output voltage has a wave form similar to Square wave so such inverter is called Square wave inverter.

3. Single phase inverter with voltage cancellation:
In case of inverter with Single phase output, it is possible to control the magnitude and the frequency of the inverter output voltage. Though the input to inverter is a constant dc voltage and the inverter switch is not Pulse width modulated this type of inverter gives a controlled AC output.

4. PROPOSED CIRCUIT

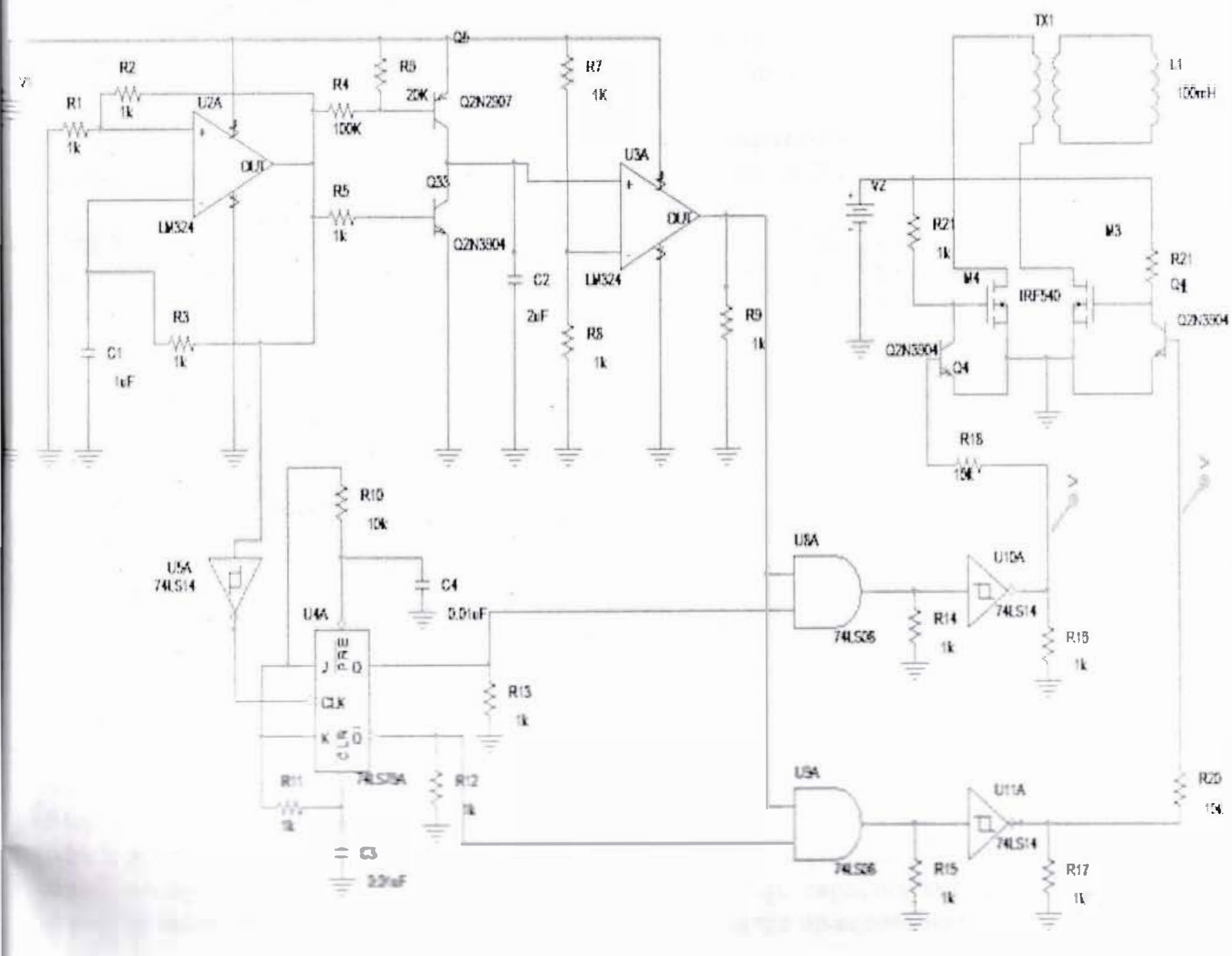

Figure 12: **Designed Inverter Circuit (Proposed).**

4.1 THEORY OF OPERATION

This circuit works in several three stages. These stages are-

1. PWM generation.
2. Switching.
3. Step-up and filtering.

The working procedure is explained below-

PWM Portion:
Step 1: First LM 324 works as frequency generator, while 5V DC input is connected. In next part it also works as comparator circuit and amplifier.

Step 2: 74LS14 this IC works in clock generating portion, Input of 74LS14 is connected in one output of LM 324. Output of 74LS14 is clocks, two clocks are generated.

Step 3: IC 74LS 76(JK flip flop) works as phase Divider **input** of 74LS 76(JK flip flop) is connected as output of 74LS14. JK flip flop shifted the phase in 180 degree.

Step 4: One output of 74LS 76(JK flip flop) and one output of LM 324 are connected to the input of the AND gate. Last of all performing and operation we get **PWM** signal as output of 74LS14. The **PWM** signal are opposite in phase, 180 degree phase shifted, and DUTY CYCLE is about 50%. PWM signal will work for switching.

SWITCHING Portion:
Step 5: Power MOSFET IRF 540 works as switching device. **PWM** out put is the input of inverter circuit. One PWM output signal makes transistor Q1 (Q2N3904) ON, that transistor makes MOSFET IRF 540 ON, so switching start.

Step 6: Another PWM output signal (180 degree phase shifting) from step 5 signal make transistor Q2 (Q2N3904) ON that transistor make MOSFET IRF 540 ●N and start switching. When one switch is ON then another switch is OFF. Both two switches are not no at the same time because of 50% DUTY CYCLE.

STEP-UP and filtering:
Step 7: In order to get expected voltage and AC output need STEP-UP and filtering the signal which generated from the inverter . Output of IRF540 as AC signal but it is not pure AC and small in magnitude so we need to make it filtering and step up. capacitor as filter if use LC filter it will be better. A step up transformer make the output voltage up according to expectation .

Experimental setup for the experiment:

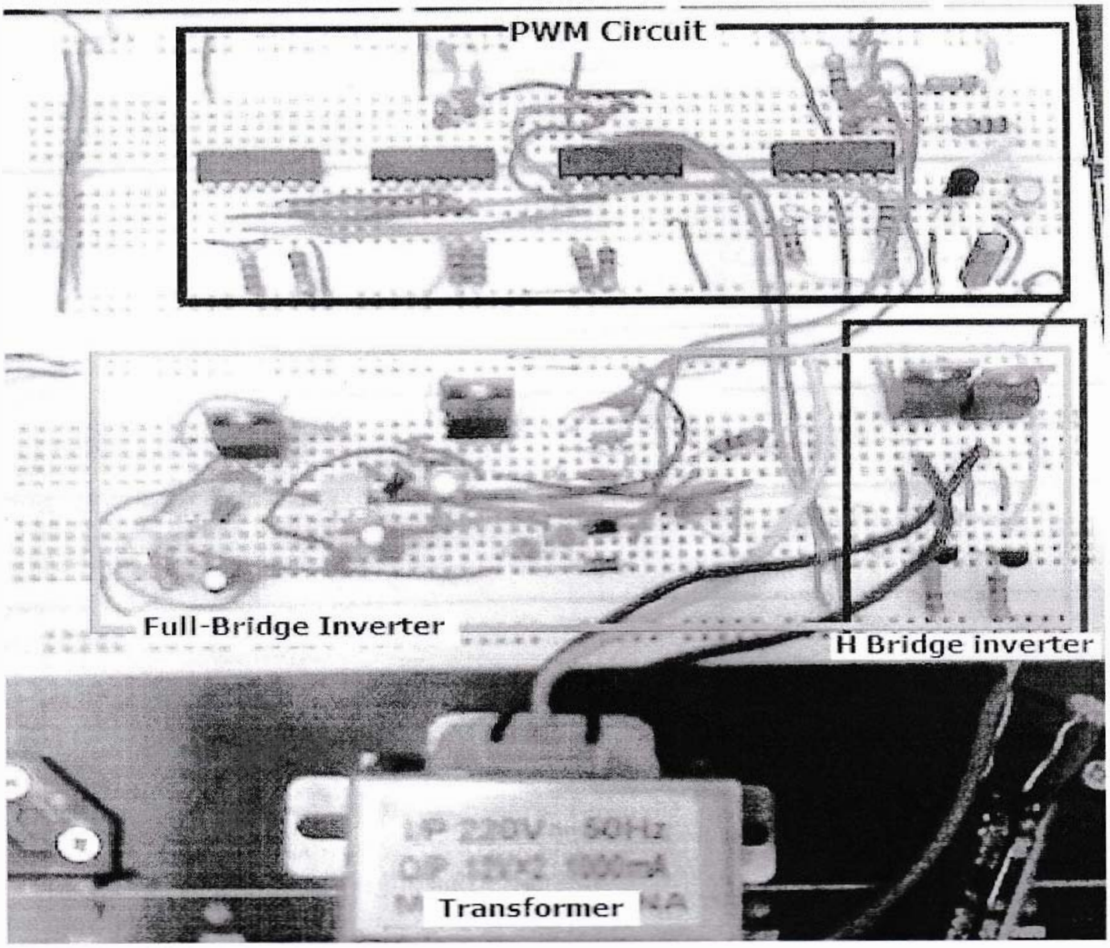

Figure 13: Experimental setup for the proposed circuit.

5. RESULTS

The designed circuit is simulated first with Orcad (version 9.2). After getting assurance that the circuit is working; the circuit has been implemented. The output data is then compared with the data we have got from simulation. The result will be discussed here in three steps as-

i. Simulation Results.
ii. Experimental data.
iii. Comparison.

5.1 Simulation Results

The simulation of the circuit has done before the circuit construction. These simulations have been done using Orcad 9.2. The PWM output was like below-

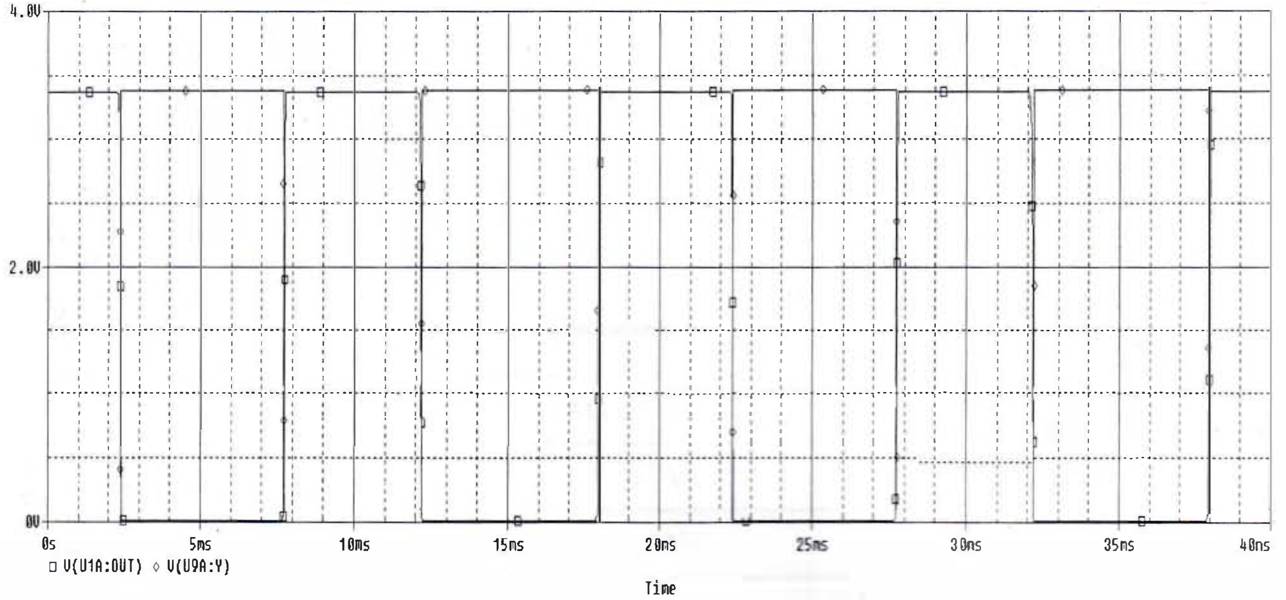

Figure 14: Pulse width modulated output square wave.

A Time domain transient simulation is simulated for 40ms. Here one thing is observable that both of the square wave magnitude is nearly 3.37 volts and both have 180° phase-shift compared to each other. For this PWM input the half bridge inverter gives an output like below-

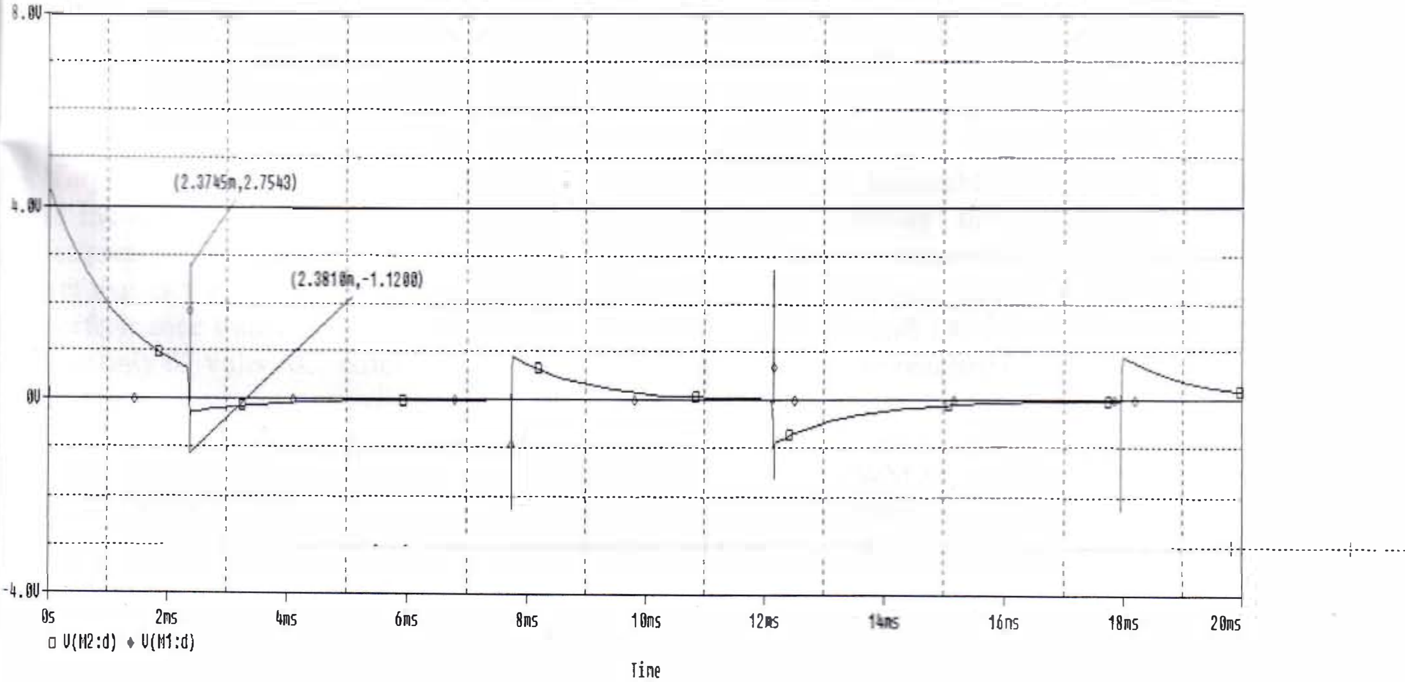

Figure 15: Inverter output for transient simulation.

The inverter output in figure 15 determines that there is also 180^0 phase-shift between each other. One of the output has a maximum magnitude of 2.75 volts another has 1.2 volts maximum magnitude. Due to a limitation of Orcad 9.2 Software the simulation for complete circuit with Transformer was impossible for us.

5.2 Experimental Results:

The designed circuit supports different input between 9 volts to 17 Volts. We have taken the results for different inputs shown in table 2 below-

Table 03: Output for Various Inputs.

DC INPUT	AC OUTPUT	FREQUENCY
9 V	67 V	50-53 Hz
10 V	74 V	
11 V	80 V	
12 V	86 V	
13 V	96 V	
14 V	101 V	
15 V	113 V	

Varying the inverter input the above output is determined. It is noticeable that the output voltage is increasing with the increasing input voltage. Another important thing is, all the time the frequency is nearly same. It is nearly 50Hz. The desired output voltage was larger but we did not get that as the power generator was unable to supply required current. For this reason, using low performance transformer has reduced the output voltage. For 9 volt DC input the output voltage was only 67 volts AC. After increasing input to 15 volt the output reached to 113 volts AC.

During the experiment different source is used for generating PWM and for Inverter circuit. For PWM circuit 5 volt DC input is used. As the input is constant, PWM wave forms are same for every step shown in figure 17. Notice that both the output has 180^0 phase-shift of each other. Both of them have a magnitude of around 3.72 volts.

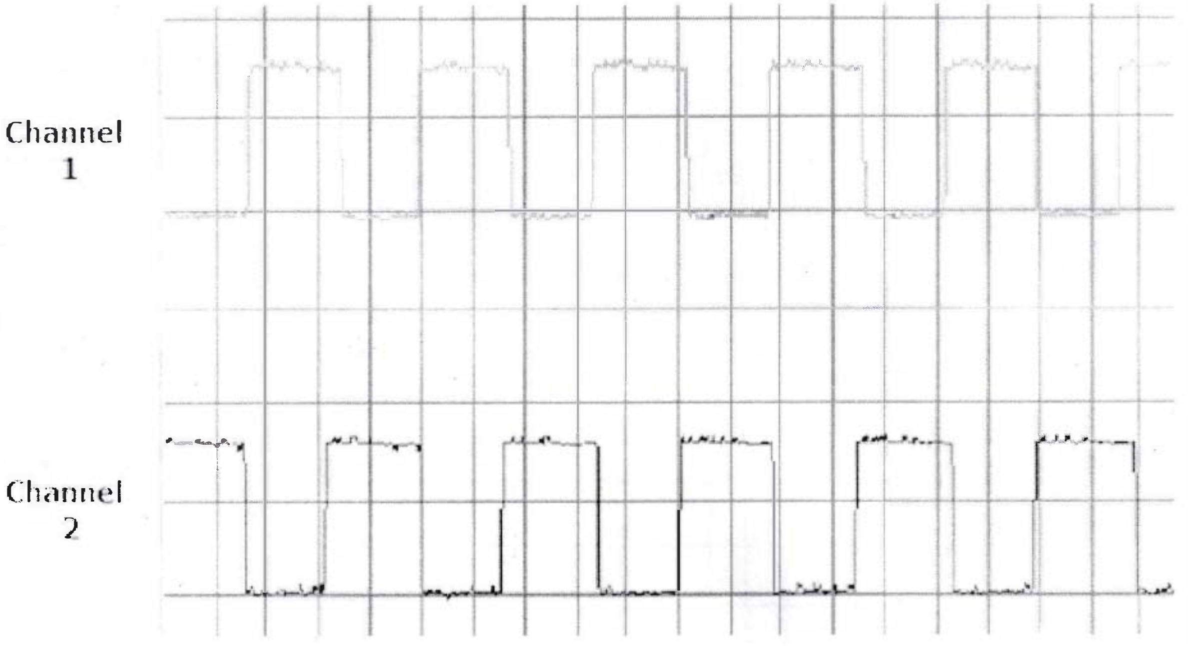

Figure 16: Pulse width modulated output square wave.

This output has taken using a digital Oscilloscope from Computer. The configuration is stated in a tabular form below-

Table 04: Configuration During PWM Data Collection.

SOURCE	VOLTS/DIV	TIME/DIV	VOLTS/COUP TIME/POS	VOLTS
CH1	2.00V	5.00ms	DC	3.73
CH2	2.00V	5.00ms	DC	3.72

This output square wave is given as input to the two switch of the inverter. The inverter output taken from computer is as below-

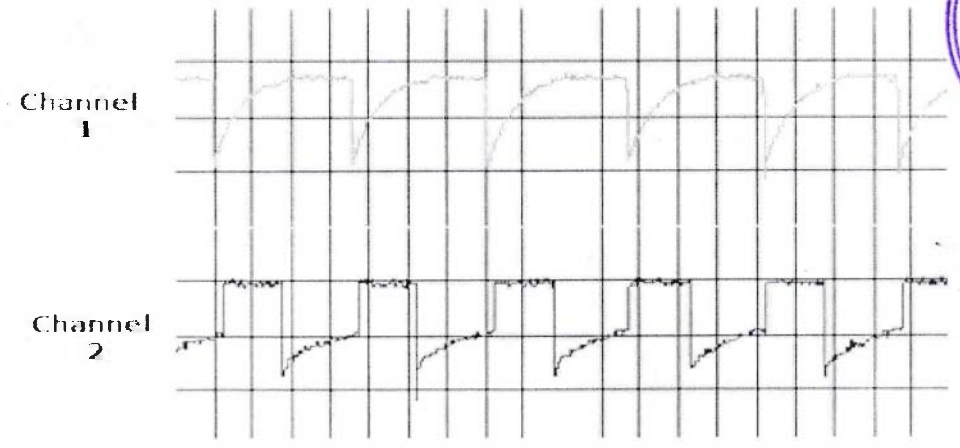

Figure 17: **Inverter output for input DC 9 Volts input.**

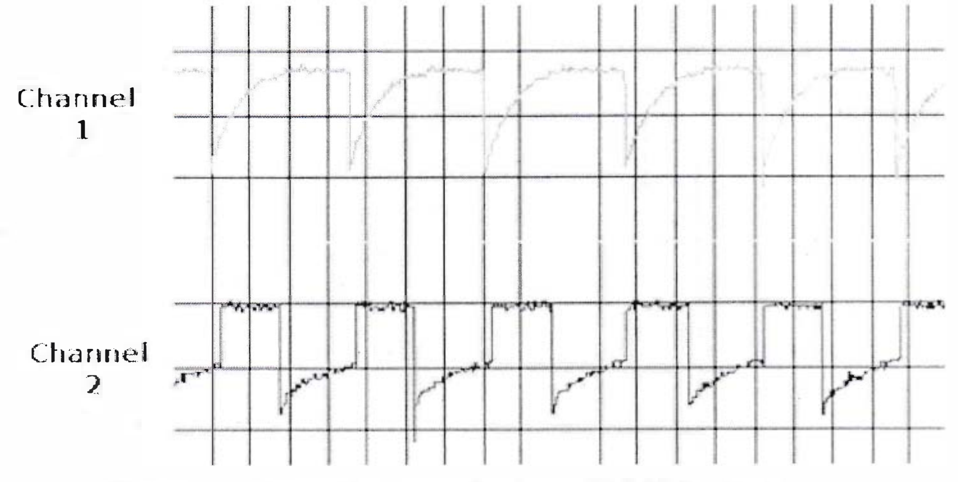

Figure 18: **Inverter output for input DC 12 Volts input.**

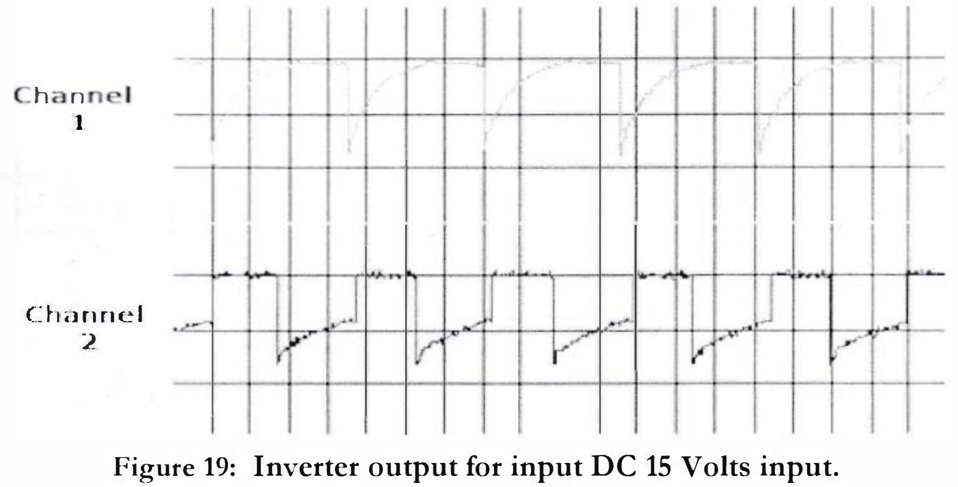

Figure 19: **Inverter output for input DC 15 Volts input.**

The voltage step-up is done by giving this output to a step-up transformer as input. After step-up and filtering the inverter output, observed AC output is as like below-

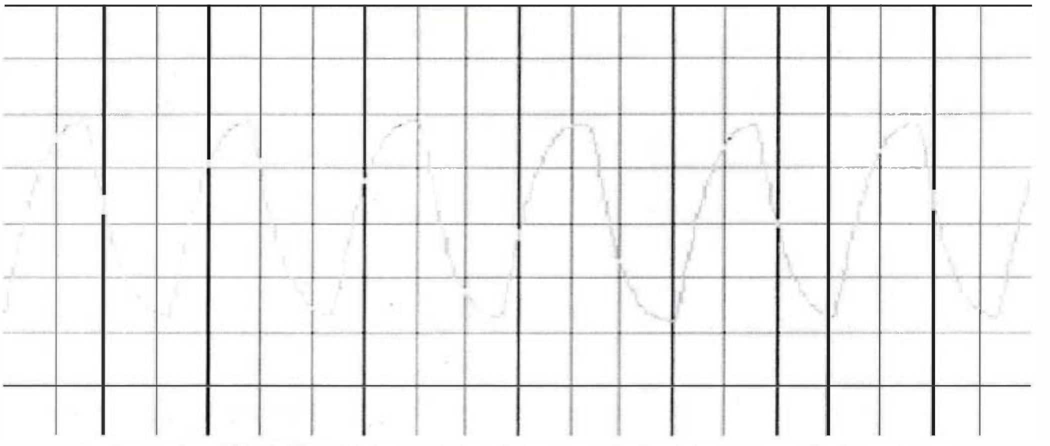

Figure 20: Transformer output for input DC 9 Volts input in inverter.

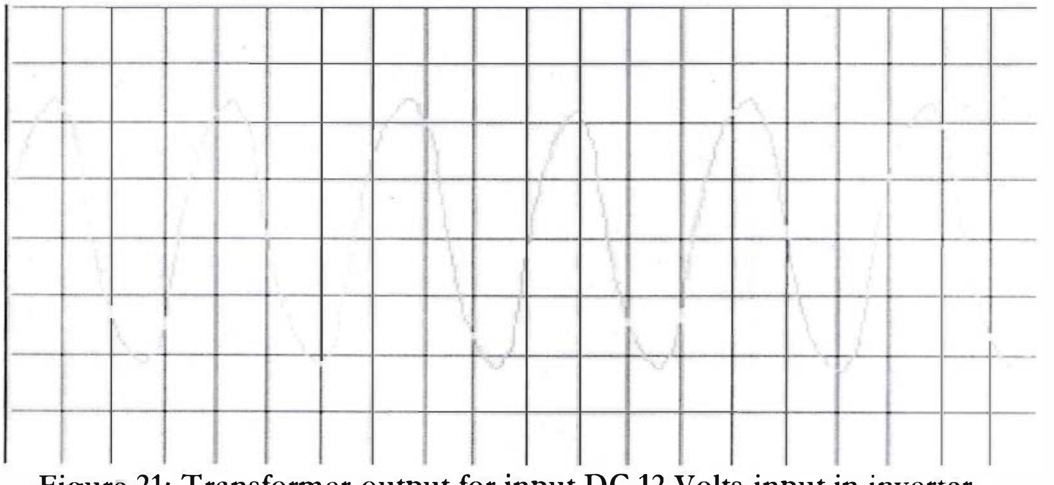

Figure 21: Transformer output for input DC 12 Volts input in inverter.

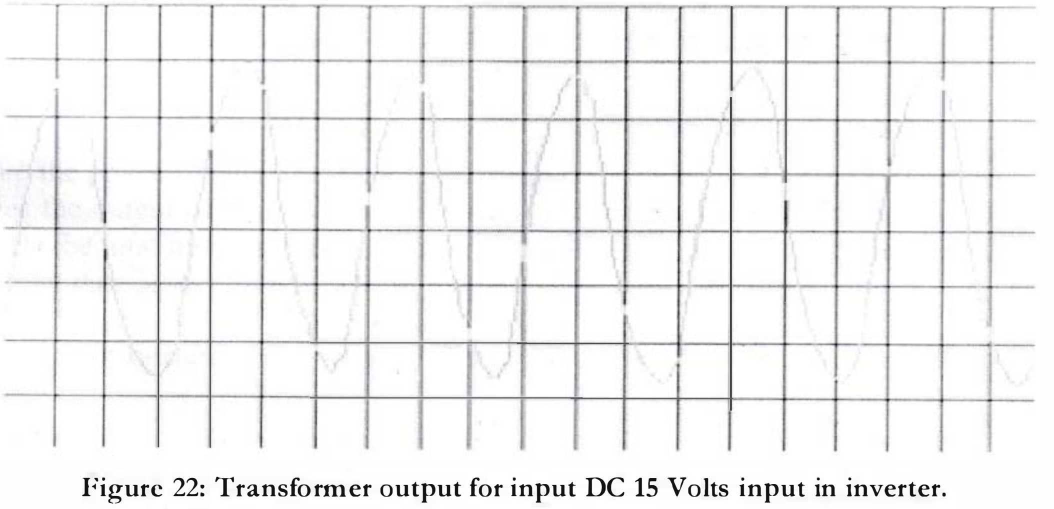

Figure 22: Transformer output for input DC 15 Volts input in inverter.

During the transformer output data observation the Oscilloscope configuration and other outputs was like below-

Table 05: Configuration During Transformer Data Collection.

FOR	VOLTS/DIV	TIME/DIV	VOLTS/COUP TIME/POS	VOLTS
Figure 21	20.00V	5.00ms	AC	67
Figure 22	20.00V	5.00ms	AC	86
Figure 23	20.00V	5.00ms	AC	113

5.2.1 Adjusting Duty cycle:

Duty cycle is the proportion of time during which a component, device, or system is operated.[4] The duty cycle is adjusted by varying a 10k potentiometer in the Place of R_5 & R_7 in the proposed circuit. All of these taken data is for 15 volt DC input at inverter & 5 volt DC in PWM circuit. Some of the results are as below-

When $R_5 = 2.12$ kΩ & $R_7 = 7.88$ kΩ the PWM output is as-

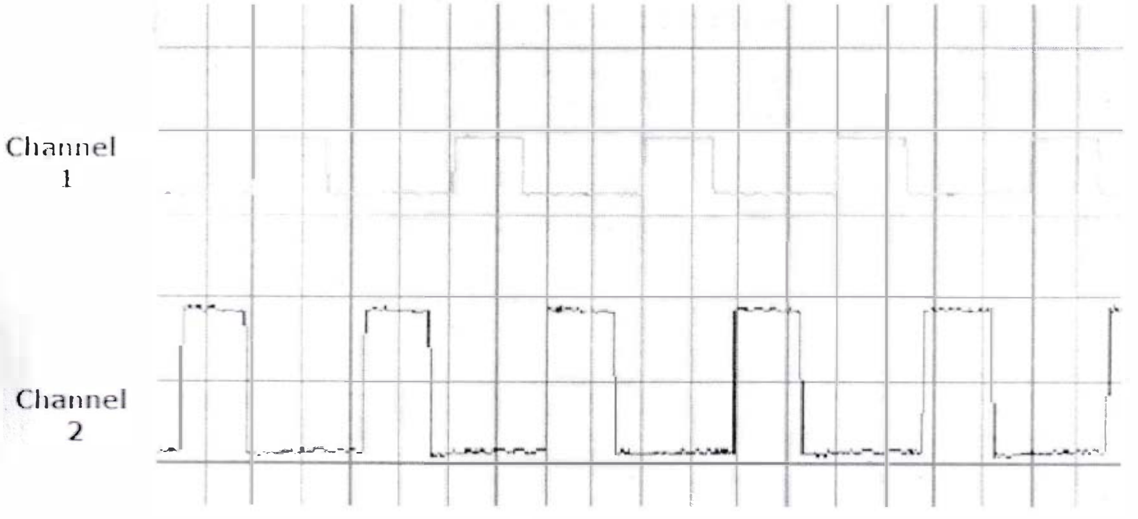

Figure 23: PWM output When $R_5 = 2.12$ kΩ & $R_7 = 7.88$ kΩ.

Setting up the potentiometer at the comparator circuit at value of $R_5 = 2.12$ kΩ & $R_7 = 7.88$ kΩ. It changes the output of the PWM wave form that is duty cycle is changing. For the change in Duty Cycle the total inverter output changes. The calculated duty cycle is about 23%. During the PWM output data observation the Oscilloscope configuration and other outputs was like below-

Table 06: Configuration During PWM Data Collection When $R_5 = 2.12$ kΩ & $R_7 = 7.88$ kΩ.

SOURCE	VOLTS/DIV	TIME/DIV	VOLTS/COUP TIME/POS	VOLTS
CH1	5.00V	5.00ms	DC	2.83
CH2	2.00V	5.00ms	DC	4.40

For the input of the above PWM input, the transformer gives an output as below-

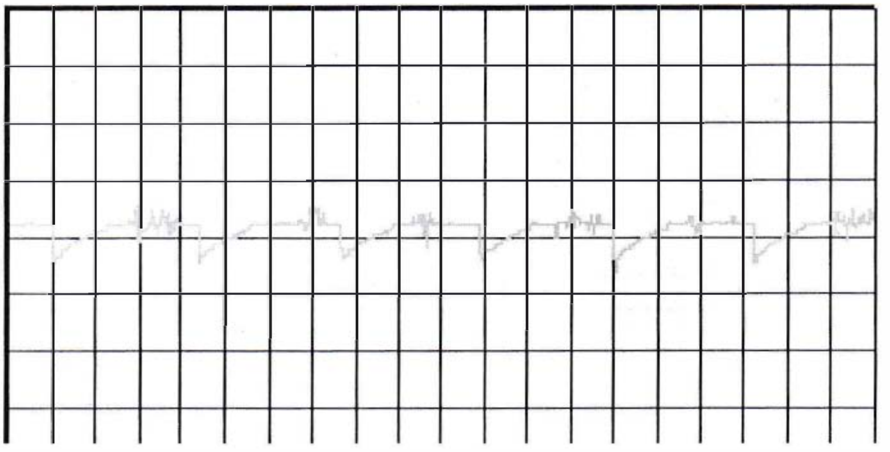

Figure 24: Transformer output When R5 = 2.12 kΩ & R7 = 7.88 kΩ.

During the transformer output data observation the Oscilloscope configuration and other outputs was like below-

Table 07: Configuration During Transformer Data Collection at R5 = 2.12 kΩ & R7 = 7.88 kΩ.

SOURCE	VOLTS/DIV	TIME/DIV	VOLTS/COUP TIME/POS	VOLTS
CH1	50.00V	5.00ms	AC	38.6

After that setting up for R_5 = 3.75 kΩ & R_7 = 6.25 kΩ. gives the PWM output as-

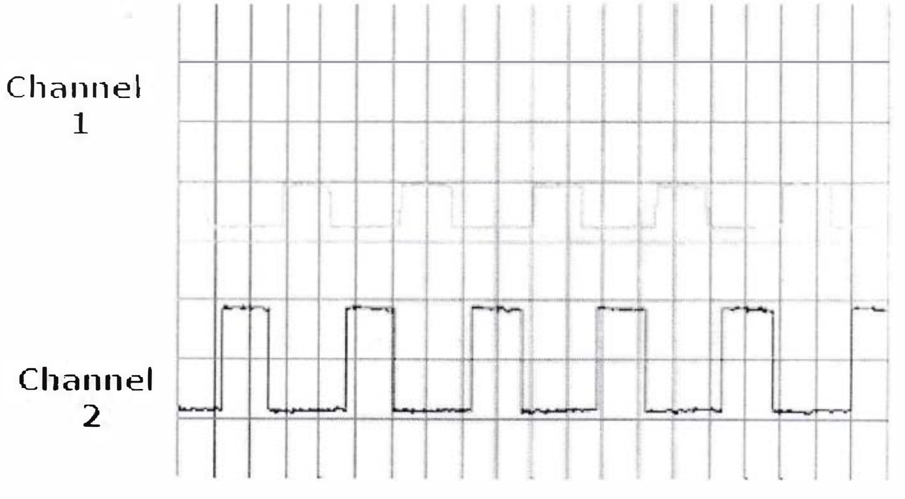

Figure 25: PWM output When R_5 = 3.75 kΩ & R_7 = 6.25kΩ.

The calculated duty cycle is about 30%. During the PWM output data observation the Oscilloscope configuration and other outputs was like below-

Table 08: Configuration During PWM Data Collection When R_5 = 3.75 kΩ & R_7 = 6.25kΩ.

SOURCE	VOLTS/DIV	TIME/DIV	VOLTS/COUP TIME/POS	VOLTS
CH1	5.00V	5.00ms	DC	3.27
CH2	2.00V	5.00ms	DC	4.12

For the input of the above PWM input, the transformer gives an output as below-

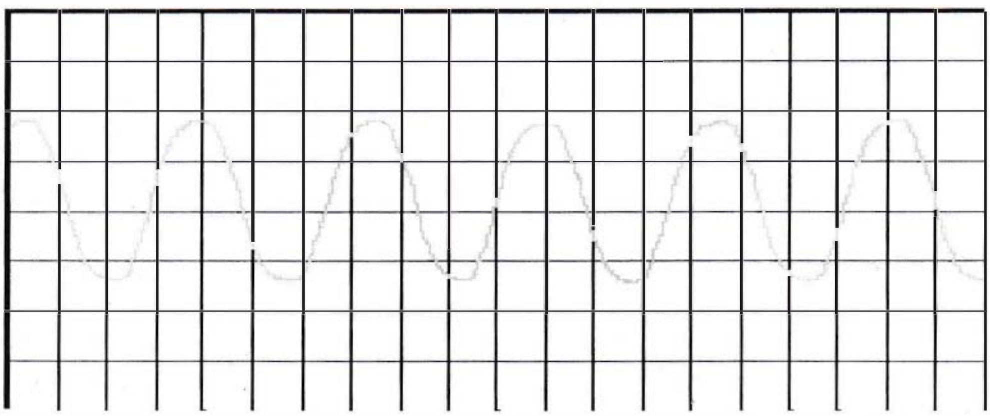

Figure 26: Transformer output When R_5 = 3.75 kΩ & R_7 = 6.25kΩ.

During the transformer output data observation the Oscilloscope configuration and other outputs was like below-

Table 09: Configuration During Transformer Data Collection R_5 = 3.75 kΩ & R_7 = 6.25kΩ.

SOURCE	VOLTS/DIV	TIME/DIV	VOLTS/COUP TIME/POS	VOLTS
CH1	20.00V	5.00ms	AC	54.6

Later on we have taken R_5 = 5 kΩ & R_7 = 5 kΩ. In this time the PWM output is as-

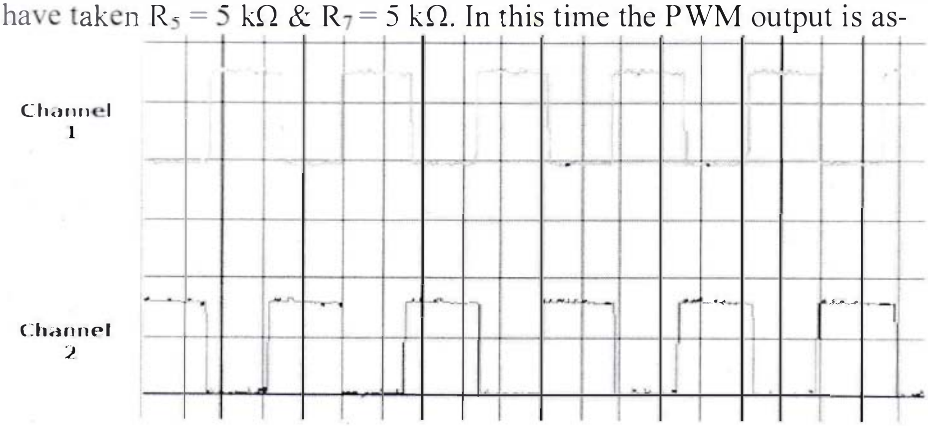

Figure 27: PWM output When R_5 = 5 kΩ & R_7 = 5 kΩ.

The calculated duty cycle is about 49%. During the PWM output data observation the Oscilloscope configuration and other outputs was like below-

Table 10: Configuration During PWM Data Collection When R_5 = 3.75 kΩ & R_7 = 6.25kΩ

SOURCE	VOLTS/DIV	TIME/DIV	VOLTS/COUP TIME/POS	VOLTS
CH1	2.00V	5.00ms	DC	3.73
CH2	2.00V	5.00ms	DC	3.72

For the input of the above PWM input, the transformer gives an output as below-

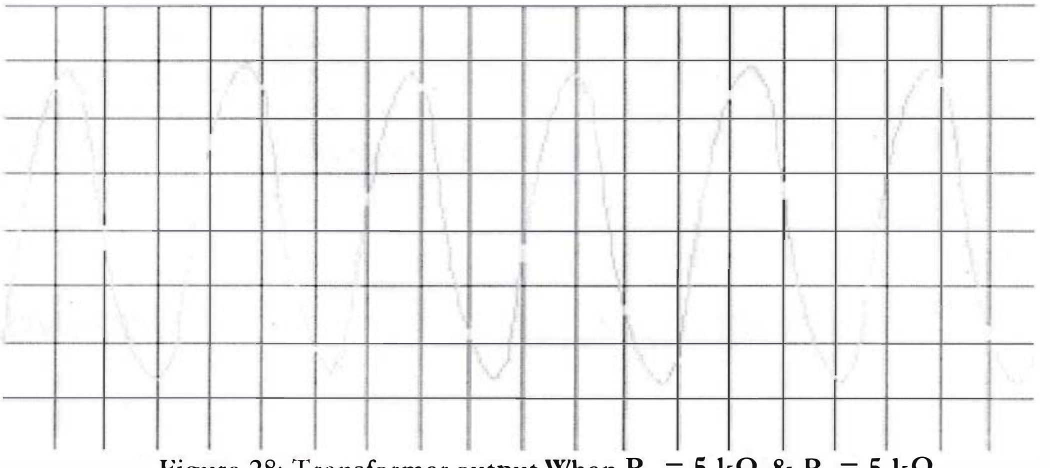

Figure 28: Transformer output When R_5 = 5 kΩ & R_7 = 5 kΩ.

During the transformer output data observation the Oscilloscope configuration and other outputs was like below-

Table 11: Configuration During Transformer Data Collection at R_5 = 5 kΩ & R_7 = 5 kΩ.

SOURCE	VOLTS/DIV	TIME/DIV	VOLTS/COUP TIME/POS	VOLTS
CH1	20.00V	5.00ms	AC	113

5.3 COMPARISON

Simulation and Experimental Results:

The simulation and Experimental results are mostly same. From the simulation data the PWM magnitude was 3.37 volts when experimental data gives a magnitude of around 3.72 volts. The inverter output is nearly same and all the time the phase-shift is 180^{0}.

Half-Bridge & Full-Bridge Inverter:

A Full-Bridge Inverter is difficult to implement compared to Half-Bridge Inverter as there is more switches in Full-Bridge inverter. For this reason the Half-Bridge Inverter is compact in size compared to Full-Bridge Inverter. At the same time Full-Bridge Inverter is more secured than Half-Bridge Inverter. Because Full-Bridge Inverter works as Half-Bridge Inverter if anyone of the Four switch damages. But there is a burn out possibility if any of the two switches damages. But Half-Bridge Inverter costs less than a Full-Bridge Inverter. For the half-bridge inverter always half of the given voltage can be found as output, but a full-bridge inverter gives full voltage as output.

5.4 ADVANTAGE & DISADVANTAGE OF INVERTER

Advantage:

The advantage of inverter is using in uninterruptible power supply. The power is available on electrical failure. No need of any resources like gas or fuel like old generator system. Even this is more compact in size also. 12V DC Inverter's provide temporary 120VAC power to our home in case of a power failure. It will also provide vehicle with 120 VAC during camp on remote locations to run fans, lights, DVD player or a laptop. We can run small fans, power to our cordless phones and lights for hours on this 750 Watt unit. A 100 watt fluorescent screw in bulb draws 23 watts and is more efficient than an incandescent bulb. A small fan will draw less than one amp and a 13" TV will draw about 60 watts. Even run our refrigerator, we will need a larger unit with 2500W. The inverter can be used in everywhere, when there is need of AC power but DC source is available.

Disadvantage:

Actually frequency matching of a converter is very tough job. It is very difficult to drive frequency sensative device with inverters. In some application if we want to operate a machine at 100 Hz frequency then we will looes torque.

An inverter for generating ac power from a dc source includes an intermediate circuit with switches used to convert dc to ac and an output side with output chokes. Normally undesireable harmonics are generated in inverters. In the subject inverter, these harmonics are eliminated by providing a feedback from the output side to the intermediate circuit. The feedback includes a feedback choke inductively coupled to the output chokes.

6. APPLICATIONS

DC power source utilization

An inverter converts the DC electricity from sources such as batteries solar panels or fuel cells to AC electricity. The electricity can be at any required voltage; in particular it can operate AC equipment designed for mains operation, or rectified to produce DC at any desired voltage.[5]

Uninterruptible power supplies

An uninterruptible power supply (UPS) uses batteries and an inverter to supply AC power when main power is not available. When main power is restored, a rectifier is used to supply DC power to recharge the batteries.[5]

Induction heating

Inverters convert low frequency main AC power to a higher frequency for use in induction heating. To do this, AC power is first rectified to provide DC power. The inverter then changes the DC power to high frequency AC power. A high-voltage, direct current (HVDC) power transmission: With HVDC power transmission, AC power is rectified and high voltage DC power is transmitted to another location.[5]

Electric vehicle drives:

Adjustable speed motor control inverters are currently used to power the traction motors in some electric and diesel-electric rail vehicles as well as some battery electric vehicles and hybrid electric highway vehicles such as the Toyota Pries. Various improvements in inverter technology are being developed specifically for electric vehicle applications. In vehicles with regenerative braking, the inverter also takes power from the motor (now acting as a generator) and stores it in the batteries.[5]

7. FUTURE WORKS

A Solar inverter or PV inverter is a type of electrical inverter that is made to change the direct current (DC) electricity from a photovoltaic array into alternating current (AC) for use with home appliances and possibly a utility grid.

- Stand-alone inverters, used in isolated systems where the inverter draws its DC energy from batteries charged by photovoltaic arrays and/or other sources, such as wind turbines, hydro turbines, or engine generators. Many stand-alone inverters also incorporate integral battery chargers to replenish the battery from an AC source, when available. Normally these do not interface in any way with the utility grid, and as such, are not required to have anti-islanding protection.

- Grid tie inverters, which match phase with a utility-supplied sine wave. Grid-tie inverters are designed to shut down automatically upon loss of utility supply, for safety reasons. They do not provide backup power during utility outages.

- Battery backup inverters. These are special inverters which are designed to draw energy from a battery, manage the battery charge via an onboard charger, and export excess energy to the utility grid. These inverters are capable of supplying AC energy to selected loads during a utility outage, and are required to have anti-islanding protection.

The inverter's role is to be the interface between two energy sources: the DC network on one side and the AC utility grid on the other. In addition to the conversion and feed-in function, the inverter is also responsible for system control and performance optimization.

8. CONCLUSION

From the late nineteenth century through the middle of the twentieth century, DC-to-AC power conversion was accomplished using rotary converters. Now a day concept of inverter is improved. At present situation in our country we are facing great problems in power, by implementing the circuit we can use it in various purpose. There are different use of inverter such as uninterruptible power supply (UPS), instant power supply (IPS), high-voltage, direct current (HVDC) power transmission, Electric vehicle drives, Air Conditioning etc.

9. REFERENCES

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